TECHNOLOGY HORIZONS JOURNAL

Vol. 2 (3), 10 March 2018, pp. 72-76

Bit Error Rate Performance Analysis of Cognitive Radio Network by Using Digital Modulation

Notyla Mohamed Elhameem, Amin Babiker A/nbi Mustafa

[a] EL Neelain University,Khartoum, Khartuom, Sudan
[b] University of Science and Technology,Khartoum, Khartoum, Sudan

Received: 14December 17
Accepted: 1 February 18

ABSTRACT

Cognitive radio networks (CRN) are smart networks that automatically sense the channel and adjust the network parameters accordingly. Cognitive radio is emerging technologies that enable the dynamic deployments of highly adaptive radios that are built upon Software Defined Radio (SDR) technology. The radio technology allows the unlicensed operation to be in the licensed band. The cognitive radio network paradigm raises many technical challenges such as the power efficiency, spectrum management, and environmental awareness. The aim of this paper is study, analyze, adaptive cognitive radio network using MATLAB software. The parameters which were taken into consideration of the adaptation were the type of digital modulation, signal to noise ratio and AWGN. The result was obtained in graphical for Bit Error Rate versus signal noise ratio and a modulation signal for primary signal and secondary signal users.

Keywords—: Software Define Radio; Simulation; Electromagnetic; Cognitive Radio.

I. INTRODUCTION

A cognitive radio network may be defined as a radio that is aware of its environment and the internal state with knowledge of these elements and any stored pre-defined objectives implement decisions about its behaviour. In general, the cognitive radio may be expected to look at parameters such as channel occupancy, free channels, the type of data to be transmitted and the modulation types that may be used. It must also look at the regulatory requirements. In some instances, knowledge of geography and this may alter what it may be allowed to do.

Radio wave is an Electromagnetic (EM) wave with all characteristic of EM waves such as interference, superposition, polarization and desperation, so if it's the media used to transmit information it should be isolated from each other by guardband avoiding all the reactions related to its nature as EM wave. Also due to this fact it was clear that the importance of issuing organizations to deal with radio spectrum, assigning bands on organized basis avoiding disturbance[1]. This led to producing a class of users with dedicated licensed bands called primary user (PU), and others unlicensed user or secondary users (SU).

Cognitive radio technology introduced by Mitola in 1999 as a pioneer idea managing the predicted problems resulted from scarcity in radio channel due to wide consuming of radio spectrum with its two types, the licensed and unlicensed [2]. The excepted scenario after few years, all of the radio spectrum will be occupied by users, either PU whom use licensed channels such as service provider or SU and this group includes

all users without licensed channel like police and military forces. So cognitive radio technology comes as an appropriate tool to solve, manage and enhance the usage of radio spectrum in its optimum situation[3]. Cognitive radio concept depends on utilization of the available unused licensed radio channel in contiguous channels, which may be unused for a specific period of time or in a limited geographical area, to the users whom they haven't licensed channel.

This simplified concept to be implemented it requires a complicated algorithm Establishing an impressive sensing mechanism leads to full awareness of the around environment with its channel modes classifying the occupied one and the others unused, to be utilized in a reconfigurable manner, solving the mentioned problem[4]. The ability of detecting and monitoring of cognitive radio system, provided by software defined radio platform (SDR), which leads to new concept called dynamic spectrum access. There are many organizations and agencies working in the field of standardization, which explains the importance and the effective role of putting standard rules to govern and manage spectrum utilization for all users. One of the proposed ways to achieve these goals is cognitive radio which considered as supportive way in dynamic access method to available radio spectrum[5]. The terminology Cognitive radio comes from the ability of cognitive system to collect data from vicinity environment, which lead the system dealing with adjacent systems with full awareness about all of it operational information, avoiding the interference of its signal and the exploit free spaces on spectrum, achieving the goal of coexistence bands with PU for SUs [6].

Cognition comes through using signal detector. There are many types of signal detector, using Energy detector to detect PU signals and determine the free space upon the spectrum to be used by SU. Then choices the appropriate modulation schemes to modulate SU signals and interleave it with PU Signals in the same band. The chosen modulation should achieve QoS requirements such as Throughput, acceptable SNR level and acceptable BER [7].

Modulation is processing the data to be transmitted over radio carrier, mainly modulation compressed data in smallest size to eliminate spectrum usage, which enhances spectrum efficiency and increases bandwidth. To achieve this goal many techniques of modulation scheme can transmit data rate 1bit/HZ, so BPSK is spectral efficient modulation [8, 9].

COGNITIVE RADIO RECONFIGURABLE PARAMETERS

Operating frequency: A cognitive radio is capable of changing the operating frequency. Based on the information about the radio environment, the most suitable operating frequency can be determined and the communication can be dynamically performed on this appropriate operating frequency.

Modulation: A cognitive radio should reconfigure the modulation scheme adaptive to the user requirements and channel conditions. For example, in the case of delay sensitive applications, the data rate is more important than the error rate. Thus, the modulation scheme that enables the higher spectral efficiency should be selected. Conversely, the loss-sensitive applications focus on the error rate, which necessitates modulation schemes with low bit error rate.

Transmission power: Transmission power can be reconfigured within the power constraints. Power control enables dynamic transmission power configuration within the permissible power limit. If higher power operation is not necessary, the cognitive radio reduces the transmitter power to a lower level to allow more users to share the spectrum and to decrease the interference.

Communication technology: A cognitive radio can also be used to provide interoperability among different communication systems.The transmission parameters of a cognitive radio can be reconfigured not only at the beginning of a transmission but also during the transmission.

II. DESCRIPTIVE ANALYSIS

The study adopted simulation method; simulation had been implemented by Matlab Simulink, using SNR and BER to determine the internal status of the system. Simulation block diagram consists of PU block, SU block, Energy detector, cognitive radio system, error rate calculator and BER monitor. PU is user with the licensed band; this band is assigned especially for transmission PU signal. The mentioned band may be set idle for a while, so another user (SU) may use it in PU absence period. PU has high priority than other SU because PU classify as the owner of the band since he has a license. PU blocks in simulation depicted in Figure 1.

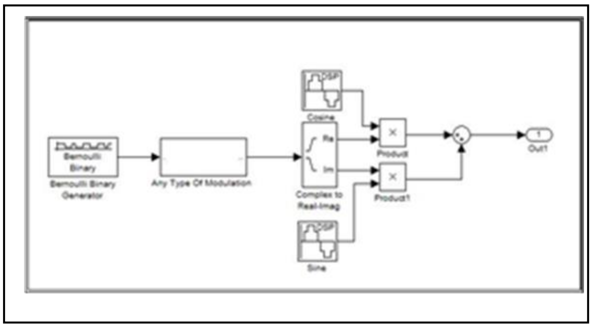

Figure 1 Primary User Block in Simulink

Is the non-commercial cooperation in the society such as police, army and emergency forces? The SU used to exploit radio spectrum in their communication to provide special services like security and helping people. SU is same like PU as technology, the difference only PU has a license. Cognitive radio gives the opportunity to send SU signal on PU band, through studying vicinity environment; determine PU spectrum characteristics and provides an appropriate frequency for SU. Energy detector one of the significant techniques used in Cognitive radio as the guidance of SU to detect white hole in PU spectrum. Energy detector designed to detect radio wave depending on its energy. Figure 2 below shown Energy detector blocks as implemented in the simulation.

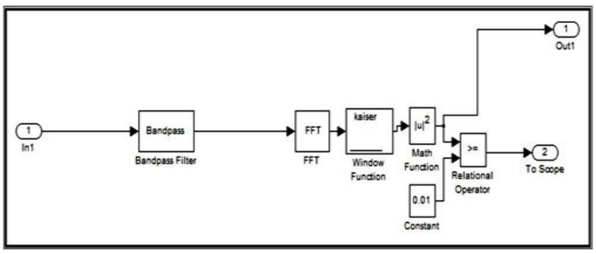

Figure 2 Energy detector

Mathematical Model

Estimated Bit error rate can be calculated as:

$$BER = \frac{\text{Number of error bits}}{\text{Number of total bits } 2a} \quad (1)$$

The implemented simulation model structure consists of the phases as depicted in Figure 3 below: Energy detector unit: the function of Energy detector unit is to provide the status of the adjacent environment to the Cognitive system. Energy detector unit used the mechanism of energy detection as one of the used method on the cognitive radio to detect PU signal and determine the white hole over PU spectrum.

PU signal detected; it will be available for the cognitive radio system to starts analysis of the adjacent environment, to choice covenant frequency to SU within PU Spectrum white spaces; or other more complex methodologies. The known used methods of coexistence SU with PU are interwoven method, underlay and overlay, where the overlay is considered as the most complicated between them. If the PU signal is not detected. Energy detector unit will keep searching to determine PU Signal Scheme.

The implementation of cognitive radio system based on the knowledge of PU signal Scheme, white space on the spectrum and idle period of the spectrum. In case of spectrum availability, SU can exploit PU spectrum, otherwise, cognitive radio system set idle. *E*…After Cognitive system successes in modulates SU signal and send it over radio spectrum, finally, BER could be calculated, measuring QoS.

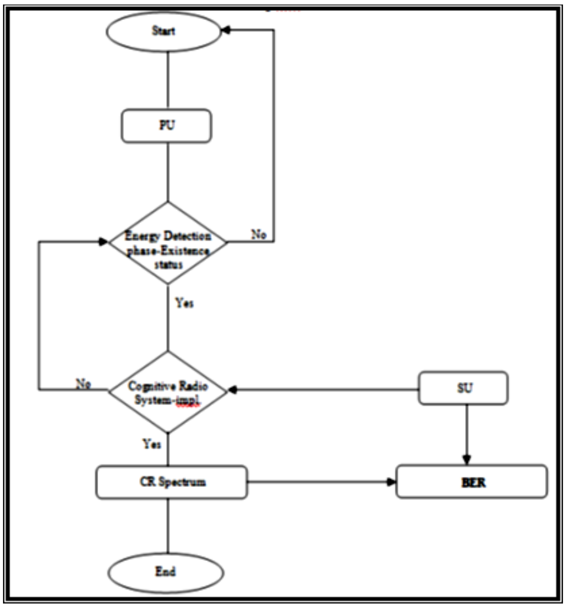

Figure 3 Cognitive radio simulation steps

III. Simulation Program

A Matlab program is executed for estimating the bit error rate at different values of the control parameters (signal to noise ratio SNR and propagation channel). The performance results are plotted and analyzed for cognitive radio network by using digital modulation. There are several reasons for selecting mat-lab program used to implement hardware components, may work in Windows and Linux environment**,** program based on multimedia application and has the ability to interface with the parallel port device technology and high-speed performance when comparing with other software programs language. The computer model is implemented using MatLab Simulink software

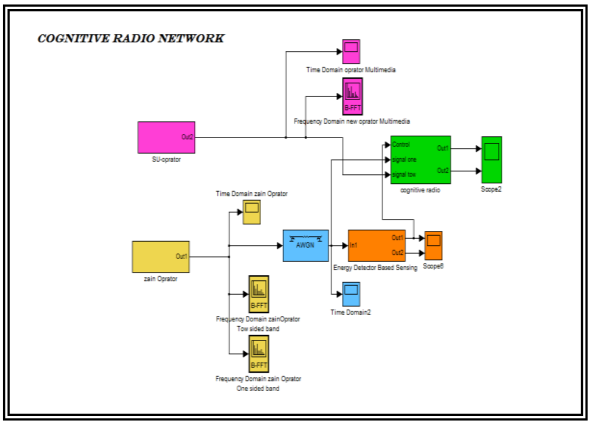

Figure 4 Cognitive Radio MATLAB Simulink

TABLE(1): SIMULATION PARAMETER

PARAMETERS	VALUES
MODULATION	BPSK,QPSK,FSK
NOISE	AWGN
SNR RANG	0-12DB
FREQUENCY	1740
TYPE OF NETWORK	PU, SU

IV. Result

After the running the simulator software program get the following result:

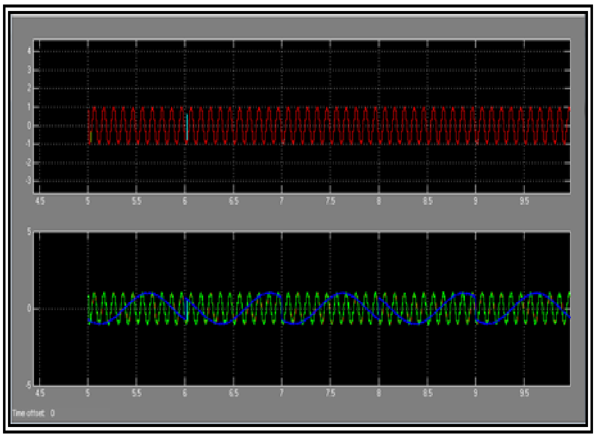

Figure 5 Shape of wave signal in cognitive radio

When used BPSK modulation in CRN get the curve of BER vs. SNR in Figure 6

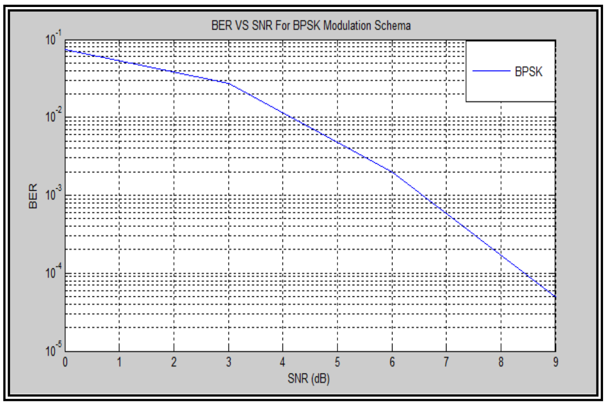

Figure 6 BER vs. SNR use BPSK modulation

When used QPSK modulation in CRN get the curve of BER vs. SNR in Figure 7

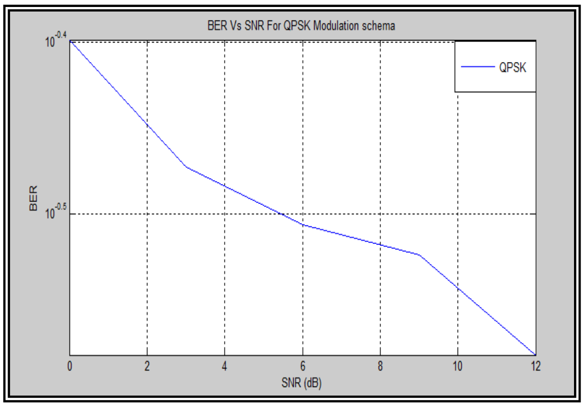

Figure 7 BER vs. SNR use QPSK modulation

When use FSK modulation in CRN get the curve of BER vs. SNR in Figure 8

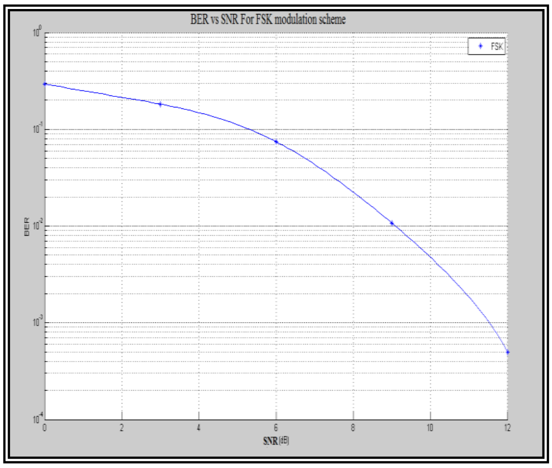

Figure 8 ER vs. SNR use FSK modulation

In Figure 4.9 compare the three type of modulation with BER vs. SNR found that the better type of digital modulation is BPSK. Then the Cognitive radio system could be treated as normal wireless system in modulation scheme effects, with advantage in sharing spectrum radio for more than one user.

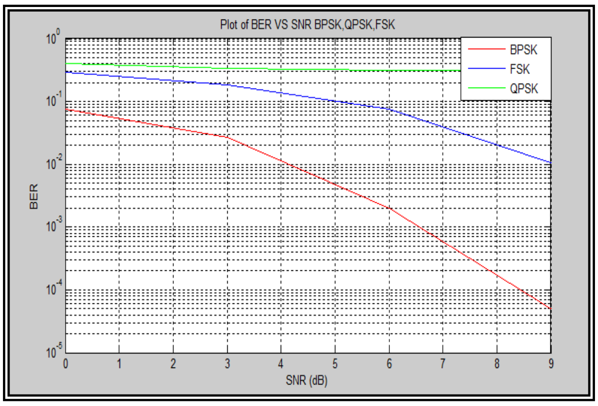

Figure 9 Comparisons between BPSK and QPSK and FSK

V. Result and Discussion

After execution of the simulation, the result was obtained in graphical form for bit error rate versus signal to noise ratio in three modulation scheme BPSK, QPSK and FSK as depicted in Figures (10 - 11). Figure 10 shows the primary user signal using BPSK, QPSK and FSK, Figure 11 Shape of signal secondary user. Note that the secondary user is using the same frequency of the primary user and same type of modulation.

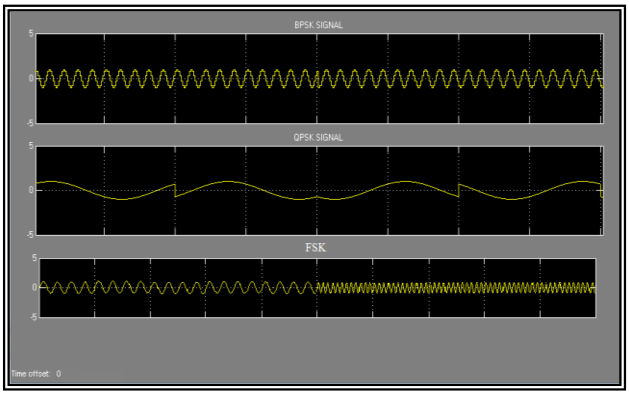

Figure 10 Primary user signal using BPSK, QPSK and FSK

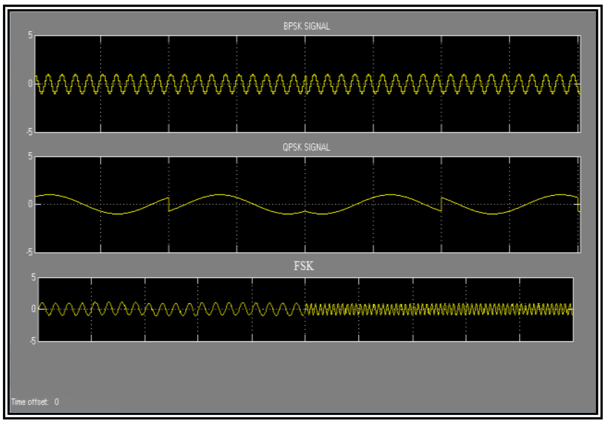

Figure 11 Secondary user signal using BPSK, QPSK and FSK

https://techhorizon.fu.edu.sd -ISSN: 1858-6368

In Figure 12, show the energy detector in primary user is used to sense the Waite space "Hole"

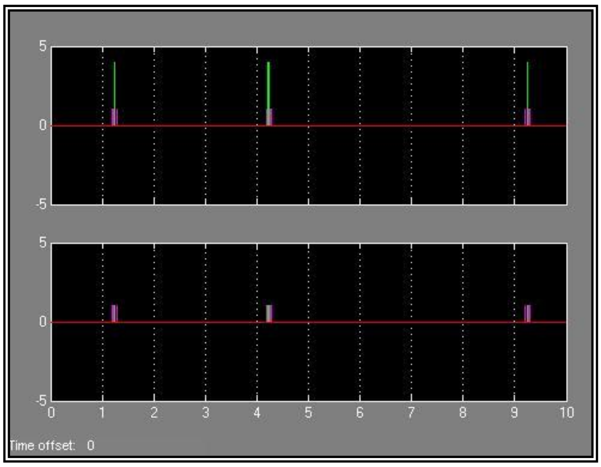

Figure 12 Energy Detector Based Sensing

VI. Conclusion

In this paper study, analysis and design Simulink by using Matlab program for study performance of cognitive radio network the parameter which taken into consideration of simulation in table 1. From the project and results, concluded that cognitive radio technology proposed to increase spectrum utilization by allowing dynamic spectrum access at a runtime and by using spectrum sensing cognitive radio find out the spectrum holes and secondary users are allowed to use that spectrum holes as long as it does not interfere by primary (licensed) users. A cognitive radio system to recycle unused spectrum to increase the total system capability is explored by using MATLAB, found in cognitive radio network bit error rate performance in BPSK modulation scheme is better than FSK and QPSK. Cognitive radio system could be treated as normal wireless system in modulation scheme effects, with advantage in sharing spectrum radio for more than one user.

Reference

1. Alexander M. Wyglinski, P.D., Maziar Nekovee, and Y. Thomas Hou, *Cognitive Radio Communications and Networks Principles and Practice.* British Library, 2009.
2. J.Mitola, G.Q.M.J., *Cognitive Radio: Making software radio more personal* IEEE communication, 1999. **6**(4).
   Hamid, M., *dynamic spectrum access in cognitive radio network: aspects of MAC layer sensing.* Blekinge Institute of Technology, 2008.
4. Javed, f., *Cognitive Radio Spectrum Sensing And Allocation Techniques* Electrical and Computer Engineering Department Centre for Advanced Studies in Engineering, Islamabad, Pakistan 2008.
5. David A, S., *Configurable SDR operation for cognitive radio application using GNU radio and universal software radio perioheral.* Blacksburg, Virginia, 2007.
6. Mitola, J., *Cognitive Radio architecture: the engineering foundation of radio XML.* 2006.
7. Ghayoor Abbas Jafri, A.U.R., Muhammad Tariq Sadiq, *Spectrum Sensing and Management in Cooperative Cognitive Radio.* Blekinge Institute of Technology, 2011.
8. Frenzel, L.E., *Principle of Electronics Communication System 3th edition* McGraw Hill, 2008.
9. H, Y.P., *Electronic Communication Techniques 5th edition* Prentce Hall, 2004.

